Gadolinium EUV Multilayers for Solar Imaging Near 60 nm, Phase I

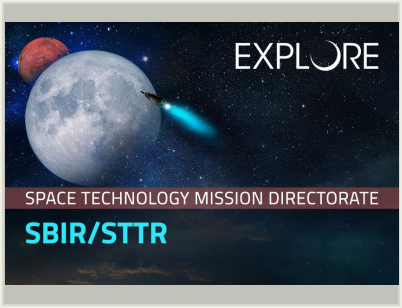
Completed Technology Project (2007 - 2007)

Project Introduction

We propose to develop and commercialize a new class of extreme ultraviolet (EUV) multilayer coatings containing the rare-earth element gadolinium (Gd), designed as efficient narrow-band reflective mirror coatings operating near normal incidence in the 60-65 nm wavelength range. This long-wavelength region of the EUV includes the important solar emission lines O V near l=63.0 nm and Mg X near l=61.0 nm, formed at intermediate temperatures in the solar atmosphere. While narrow-band EUV multilayer coatings are by now widely used in NASA missions for high-resolution solar imaging at wavelengths shorter than 35 nm, the observations made at those wavelengths probe coronal and transition region lines formed at either low (e.g., He II at l=30.4 nm) or high (e.g., numerous Fe lines) temperatures. In contrast, the 6065 nm wavelength region provides a unique spectral window in which to observe intermediate-temperature solar emission lines. However, efficient multilayer coatings operating in this range have been unavailable until now. The successful development of efficient, stable Gd-based multilayers as we propose, based on preliminary experimental results, will therefore enable the construction of new high-resolution solar telescopes tuned to O V or Mg X that will complement existing multilayer telescopes tuned to shorter EUV wavelengths, thereby providing more complete temperature coverage, and leading to better understanding of the solar atmosphere, its variability, and its crucial role in driving space weather. EUV imaging instruments incorporating the multilayer technology we propose to develop may be included in future missions such as RAM, Solar Probe, and Solar Orbiter, as well as future GOES satellites and new Explorer-class missions. The proposed innovation thus directly supports NASA's SBIR "S3.04 Optical Devices for Starlight Detection and Wavefront Analysis" subtopic.

Anticipated Benefits

The same Si/Gd coatings developed in this proposed SBIR project will also enable the construction of related high-performance imaging and spectroscopy systems, for other organizations engaged in solar physics missions such as NOAA, ESA, etc., as well as researchers in the US and abroad involved in a variety of non-solar scientific and technological disciplines including plasma physics, synchrotron radiation, photo-lithography, and EUV laser research. Our research and the resulting commercial products will therefore have a broad impact on the scientific community in general. The successful completion of our proposed SBIR activities will result in the development and commercial availability of affordable, high-performance Si/Gd EUV multilayers that operate near normal incidence in the 60-65 nm range, a region of the EUV in which no narrow-band multilayers are currently available. These coatings will enable the construction of high-resolution, high-cadence, narrow-band imaging telescopes for solar observations of intermediate temperature O V and Mg X lines, thereby complementing existing EUV multilayer coatings that operate at shorter wavelengths. Such telescopes may find application in future NASA



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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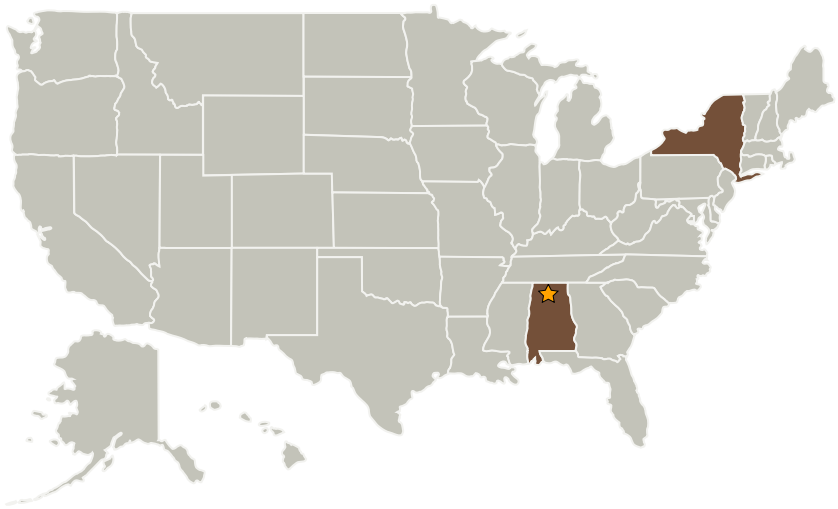
solar physics missions including Solar Probe and RAM, as well as future GOES satellites and Explorer-class missions.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
Reflective X-Ray Optics LLC	Supporting Organization	Industry	New York, New York

Primary U.S. Work Locations	
Alabama	New York

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Project Manager:
William D Jones

Principal Investigator:
David Windt

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.1 Photovoltaic